they might have upon their surface a sufficient amount of poison to produce injurious effects, would seem above suspicion.

The results obtained from spraying various fruits with a combined fungicide and insecticide in 1892 convinced the writer that too great care cannot be taken in the use of these poisons upon all crops, any exposed portions of which are edible, and that in no case should they be used within one month of the time of ripening, while an interval of six weeks to two months will be preferable. The fruits experimented upon were strawberries, raspberries, currants, gooseberries, cherries, and pears. The experiment was conducted in the same manner with all of the fruits, and when ripe they were analyzed and tested for arsenic and sulphate of copper. The spraying was done about as in ordinary practical work, except that it was rather more thorough, the amount used being perhaps double that generally employed. Except that the raspberry and strawberry retained rather more of the poison, the results were quite similar, and those obtained with two of the fruits will answer for all.

Gooseberries sprayed June 18, 29, July 8, and 22 with Bordeaux-mixture (copper sulphate, 2 pounds; lime, 1½ pounds; water, 32 gallons) and London purple (1 pound to 200 gallons), using one-half gallon of the mixture to a very thick, full row two rods long. One pound of fruit gathered Aug. 2 gave, on analysis, .0365 grains of arsenic and .355 grains of copper sulphate. In making the analysis, the fruit was first washed in ten per cent hydrochloric acid, and the amounts of arsenic and copper sulphate thus abstracted were, respectively, .0203 grains and .208 grains, after which there remained of each .0162 grains and .147 grains.

Fruit from another row that had been sprayed in a similar manner, except that the Bordeaux-mixture was made from the usual formula (copper sulphate, 6 pounds; lime, 4 pounds; water, 32 gallons), gave of arsenic .0723 grains, and of copper sulphate .62 grains, from one pound. In each case the last spraying was eleven days previous to the date of picking.

The pears were sprayed with the same mixture as the first lot of gooseberries, on June 15, July 7, 21, and Aug. 7, and were gathered and analyzed Sept. 6, or thirty days after the last application. The result from one pound of fruit gave, of arsenic .0089 grains, and of copper sulphate .0745 grains.

The above analyses were made under the direction of Dr. R. C. Kedzie, chemist of the Michigan State Experiment Station.

Attention is called to the fact that only about one-fifth as much copper sulphate was found upon the pears thirty days after spraying as upon the gooseberries gathered eleven days after receiving the last application, also that with a weak solution as compared with a strong one, the amount both of copper and arsenic remaining upon the fruit was reduced in about the same ratio as the strength of the mixture used.

This certainly emphasizes the advice previously given, (1) to use a solution as weak as will secure freedom from disease, and (2) cease spraying with all poisons at least one month before the fruit ripens.

LIGHTHOUSE ILLUMINANTS.

BY WM. P. ANDERSON, CHIEF ENGINEER OF MARINE DEPARTMENT, OTTAWA, CANADA.

IN *Science* for Feb. 6, 1885, a sketch was given of the progress of lighthouse illumination in Great Britain and Ireland, together with a short description of the strongest lights and apparatus utilized up to that time. Since that article appeared the conflict between the advocates of electricity, mineral oil, and gas, respectively, has not decreased, nor has any settlement satisfactory to all parties yet been reached. The matter has on several occasions been brought before the Imperial Parliament, and in February last some further correspondence on the subject was laid before the House of Commons.

A consideration of some of the points lately elicited will be an interesting addition to Mr. Kenward's notes on lighthouse apparatus in *Science* for April 21 last.

The lighthouses of the United Kingdom are under divided control: the English lights are managed by the Trinity House, the Scotch lights by a board of commissioners, and the Irish lights by a separate commission; all under the general direction of the Government Board of Trade, and each anxious to maintain lights of the highest efficiency, almost regardless of cost.

The English authorities, from the observations made in 1885, are satisfied of the superiority of electric arc-lights where the highest possible power is required, and consider oil-lights the cheapest and most easily managed for ordinary purposes. The Scotch commissioners endorse this view of the case; but the Irish board seems to favor the use of illuminating gas.

The chief opposition to the decision of the English Trinity House appears to be instigated by Mr. John R. Wigham of Dublin, the inventor of the gas system. He claims that he did not get fair play in the trials of 1885, because a rule was adopted restricting the size of the lenses and lanterns within limits that prevented him from obtaining the best results from his gas-lights. Since that time he further claims that by enriching common gas with hydrocarbon a greater amount of light can be obtained from it than from the richest cannel-coal gas. Actual experiments have shown that cannel-coal gas has an illuminating power of 28 candles, nearly double that of ordinary Newcastle-coal gas, 16 candles. By passing the ordinary gas through the vapor of solid napthaline, or albo-carbon, a perfectly safe and inexpensive material, it is enriched with hydrocarbon to such an extent as to give double the illuminating power of cannel gas. He also suggests, as an improvement in lighthouse illumination, placing lenses so as to form a quadrilateral or trilateral figure, which would permit the use of lenses of much larger illuminating surface and of much longer focal distances than is possible with the 6, 8 or even 16-sided lenticular apparatus heretofore used, thereby immensely increasing the illuminating power of the lighthouses.

Mr. Wigham has had a lens of long focus made, with a bulls-eye or central portion 19 inches in diameter, and two concentric rings, one 4 and the other 4½ inches wide, giving a total diameter of 36 inches, all in one piece. This is surrounded by a belt of prisms 2 feet 10 inches wide, consisting of ten rings, outside of which is a third portion consisting of eight rings of totally reflecting prisms, partially surrounding the second portion, so as to complete a lens about 10 feet 10 inches wide by about 8 feet high. In the focus of this lens is placed an "intensity" burner composed of 148 fish-tail jets, grouped to burn the enriched gas, which, when lighted, forms a solid flame of 14 inches diameter by 6 inches high. The illuminating power of the burner is calculated to be about 8,500 candles, which should give an actual intensity of light through the lenses of about 2,300,000 candles. Experiments made with this apparatus showed splendid results at a distance of 6½ miles. In full moonlight the beam cast a strong shadow, and was very large and dazzlingly bright, reducing a neighboring first-order fixed light to what seemed by comparison a remote and feeble glimmer.

The case for and against gas as a lighthouse illuminant seems to be as follows: Its advantages are facility in increasing or decreasing the power of the light to suit the various states of the atmosphere, and also speed and sharpness in eclipsing lights by cutting off the supply of gas, and thus occulting them while at the same time saving the illuminant; as well as the fact that where gas is used for illumination it can be utilized at a minute's notice to operate a gas-engine in connection with a mechanical fog-alarm, while with any other source of power delay must occur in putting the fog-alarm into operation. It is further claimed that the large size of the gas-flame, giving an unusual number of extra-focal rays, has a better effect in illuminating a large area of fog, and consequently makes the light more readily visible.

The weak points of gas are the difficulty of manufacturing it at some isolated stations, and also the necessarily large size of the flame, which involves the use of very large lenses, and a long focus, to prevent a wasteful distribution of extra-focal light.

The arrangement of illuminating apparatus proposed by Mr. Wigham for a most powerful light is a battery of four giant lenses, surrounding a central burner, intensified by having similar lenses with additional burners arranged one over the other in three tiers, or "in triform." To accommodate such an apparatus would require a lantern with glazing at least 20 feet in diameter

by 24 feet high. The lenses alone would cost £8,400, an expenditure which would only be justified by the necessity for an exceptionally powerful light.

Mr. D. A. Stevenson, Engineer to the Northern Lighthouse Board, in a report on electric light as an illuminant, claims that the complaints against the penetration of this light in fogs are not well founded, and that many criticisms of its power are due to prejudice, partly owing to the persistent way in which it is decried as a lighthouse illuminant by certain writers to the press, partly from a misunderstanding of the fact that, being very rich in the most refrangible rays of the spectrum, that is, very white, it suffers a greater percentage of diminution in passing through fog than oil or gas light, which is redder, but nevertheless, owing to its enormously greater initial power, the electric light is always a better penetrator of fog than the others. He claims that sailors, on their ordinary courses, are never in a position to form an opinion of the subject that is worth anything, because they cannot see different lights in the same conditions of atmosphere. He adduces observations made by keepers in his service on each other's lights, which go to prove that the electric light is in all cases the more powerful. These are observations from one station burning an oil light to another electrically lighted, and the reverse. Three pairs of such stations are instanced; in every case the electric light being visible in fog that totally obscured the oil lamp.

THE COLLECTION OF FOSSIL MAMMALS IN THE AMERICAN MUSEUM OF NATURAL HISTORY, NEW YORK.

BY HENRY F. OSBORN, COLUMBIA COLLEGE, NEW YORK CITY.

THE third expedition from the Museum is now in the field, and the collections of fossil mammals made under the direction of Dr. J. L. Wortman during the summers of 1891 and 1892, are being rapidly prepared for exhibition upon the geological floor of the museum. The first year's work was in the Wahsatch beds of the Big Horn Mountains, a country which had been very thoroughly explored for Professor Cope. This yielded rather disappointing results, although exceptionally fine material of *Coryphodon* was procured, including very considerable portions of the skeleton, which will soon be mounted for exhibition in the museum. The most unique discovery in this horizon was the skull of *Palæonictis*, an ancient carnivore which has hitherto been represented only by two lower jaws found in the Suessonian of France, the horizon contemporary with the Wahsatch.

Early in 1892 Dr. Wortman, accompanied by Mr. Peterson, who had been for several years on the U. S. Geological Survey, started into the Puerco or basal Eocene beds of northern New Mexico, and by the most energetic and careful search in fields which had also been explored for Professor Cope, succeeded in procuring a very valuable collection of these Lower Eocene types. Among the most unique specimens of this series are the upper and lower jaws of *Polymastodon*, a large-sized successor of the ancient *Plagiaulax* of the Middle Jurassic beds. Another discovery was the skull of *Pantolambda*, an ancestor of Coryphodon. Altogether nearly five hundred specimens were shipped East from this tour. The party then went into the Laramie, in search of the Triceratops, but were unsuccessful. They secured later in this horizon a large collection of the minute teeth of the Cretaceous mammals, which is paralleled only by that in the U. S. Geological Survey collection.

The richest results obtained thus far, however, are from the White River Miocene of South Dakota. Here the beds are 800 feet thick, and a thorough exploration was made from the bottom series in which the huge *Titanotherium* is found, to the top in which the new forms *Protoceras*, *Artionyx* and *Aceratherium tridactylum* were found. These top beds were practically a discovery, for nothing has been recorded from this stratum before, excepting the skull of a female *Protoceras*, which is in the U. S. Geological Survey collection. The male *Protoceras* presents four pairs of protuberances upon the skull, the most exceptional being the large vertical plates upon the maxillaries. This White River Miocene is the classic ground of Leidy's memoirs, but in these and by far the greater part of the literature of this horizon, the animals only of the so-called "Oreodon" stratum have been described, together with the forms from the lower "Titanotherium" stratum. This has been due to the fact that these strata at once attract the ordinary collector by the profusion of bones which are washed out from them. An intervening stratum between the "Oreodon" and "Titanotherium" layer, appears, also, to have been generally overlooked, because of its unpromising exterior. Mr. S. Garman, collecting for the Museum of Comparative Zoölogy, some years ago secured one specimen of the very unique Rhinoceros-like form, *Metamynodon*, the type specimen and the only one which has hitherto been known. Dr. Wortman directed his attention, therefore, especially to the location of this stratum, and succeeded in finding a seam about thirty feet in thickness, which proves to be especially characterized by abundant remains of Metamynodon. The party secured four or five skulls, and one nearly complete skeleton. This animal is distinguished by huge canine tusks in the anterior portion of the head, which give it an appearance quite different from that of the rhinoceros; in fact, the skull and skeleton are entirely peculiar, and unlike any perissodactyl which has been found hitherto. Yet this animal flourished in the midst of large herds of true rhinoceroses, for the diligent search made by the museum party has resulted in the discovery of a whole series of hornless rhinoceroses, from the bottom of these beds to the top. They increase gradually in size, and in the evolution of the teeth, in the loss of the lateral fifth toe in the fore foot, and reach a culminating point in the new species, *Aceratherium tridactylum*. As the name indicates, this species is mainly characterized by the presence of but three toes in the fore foot. It is represented in the museum collection by one of the most remarkable specimens which has ever been found. This is a complete skeleton from the tip of the nose to the tip of the tail, lacking only the fore limb of the left side, and a few of the ribs and sternal bones. It is over seven feet long and four feet high, and has been mounted upon a large panel of sandstone and plaster, giving the impression that it has been simply hewn out of the matrix. The animal appears to be of about the same size and proportions as *Ceratorhinus* or the rhinoceros of Sumatra; in fact it has very nearly the same proportions and form, except that it lacks the small horns upon the nasals and frontals. Among American species its affinities are with the *Aphelops megalodus* Cope of the top of the Miocene.

A third specimen of note is the hind foot of *Artionyx*. As Leidy called Oreodon a ruminating hog, so this animal might be called a clawed hog, for the foot closely resembles that of the pig or peccary, until we reach the phalanges, which have articulations and large terminal claws somewhat similar to those seen in the bears, while the ankle-joint is of the artiodactyl type, and the four toes are set in pairs on either side of the median line, there being also the rudiment of a fifth. The name given this fossil refers to its combination of the artiodactyl and unguiculate character. This is possibly a relative of the clawed Ungulate — *Chalicotherium* — which presents such a remarkable combination of characters, and is now known to have been distributed over North America, Europe, and Asia, during Miocene times. The contrast between these two types is very striking; for while Artionyx combines an artiodactyl foot with uncleft claws, Chalicotherium combines a perissodactyl foot with cleft claws. One of the most interesting problems of the future will be clearing up the relations between these two forms and their relations to other groups.

CURRENT NOTES ON ANTHROPOLOGY.—XXVII.

[*Edited by D. G. Brinton, M.D., LL.D.*]

Theories in Criminal Anthropology.

Two articles which appeared almost simultaneously in February last present with sharpness and brevity the conflicting views of the two leading schools of criminal anthropology.

One is by Dr. Sorel, in the *Revue Scientifique*. It is a warm defence of the doctrines so strenuously urged by Professor Lombroso, and which were substantially repudiated at the Congress of Brussels last year (see *Science*, Nov. 18). Sorel maintains